Review On Handover Efficiency and User Data Rate in Hybrid Li-Fi and Wi-Fi Network

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***Abstract*—**As Li-Fi attocell covers a significantly smaller area than a Wi-Fi AP; this means that even with moderate user movement a large number of handover between Li-Fi attocells can occur. The main objective of this work is to study by using small Li-Fi attocell enhances the throughput with additional illumination and handling user data rates with respect to increasing users within Li-Fi and Wi-Fi access point. This paper discusses the model of exploring hybrid model (Li-Fi/Wi-Fi) and associated simulation of hybrid network where in modification in number of attocell in a plane results in enhancing the throughput.

In recent past, Li-Fi is attracting attention to enhance the throughput in Wi-Fi solution in local area network. The hybrid solution of Li-Fi and Wi-Fi is also explored to resolve the throughput issue. The handover among the Li-Fi and Wi-Fi network is a main issue which can be resolve through attocell.

Index Terms—Li-Fi, Wi-Fi, Hybrid network, Handover efficiency

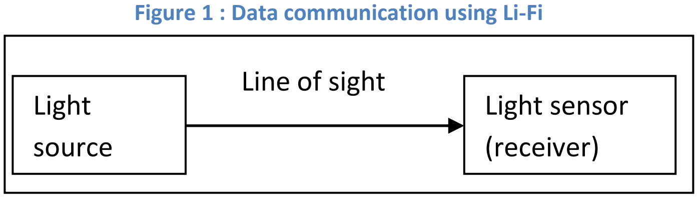
I. Introduction

Since light is present everywhere, if we can relay such information, it would be very practical. That's where Li-Fi engineering (Light Fidelity) comes into play[6]. Through Li-Fi, digital data transmission occurs with flickering frequency controlled by different currents with LED bulbs.The work is simple as illustrated in Figure 1[6]. At one end there is a light emitter. It can be just LED light emitter. A virtual ' 1 ' will be transferred when the LED is on. [1] A digital ' 0 ' is transmitted when the LED is off. A photo detector at the other end receives [6].

This refers to a transmission of one bit of data. A number of LEDs can be connected to allow a large volume of data transfer[6] [3]. Speed is dependent on the frequency of LED intensity variability[5]. Data is encrypted and transmitted in this way. During the design process, the main factors to take into account are

- Line of Sight (LoS)
- Presence of Light
- Illumination

Figure 1 : Data communication using Li-Fi



The new technologies in future indoor wireless communications include hybrid LED (Li-Fi) and Wireless Fidelity (Wi-Fi) networks[2]. The high speed data transmission offered by visible light communications and the wider coverage of radio frequency technologies are combined in this hybrid network[1].While a hybrid network can boost system performance and user experience, the choice of access points (APs) is difficult due to the combination of heterogeneous access points [2]. Differences between uniform and heterogeneous APS networks, and a two-stop APs method for hybrid Li-Fi / Wi-Fi networks is proposed [2].In the first stage the consumer should be connected to Wi-Fi with a smooth logic process, the remaining users are assigned in a homogeneous Li-Fi network environment in the second phase [2]. The proposed method achieve close to optimum output with significantly reduced complexity in comparison with the optimization method [3].

In standard indoor environments, the coexistence of radi o frequency (RF) and visible light communication (VLC) can be advantage to meet large consumer quality of service (QoS) requi rements [3]. Actively supporting feature is a hybrid RF / VLC network in which data is transmitted via either a RF access point or a selection technique-based VLC light [2]. Use of definition of productive efficiency, which defines the permissible constant rate of arrival at the transmitter buffer when the QoS needs are placed as limits on buffer overflow and chances of delay violation, as the main selection requirement [1]. In another case, Li-Fi and Wi-Fi hybrid network have used one line of Li-Fi access point [5] to view the user's working requirements with data rate flow. The user data rate were calculated and realized that only a small number of users operate with Li-Fi AP and others send to the Wi-Fi AP [5].

The hybrid system provides significant performance, robustness, reliability and safety advantages, which are essential for the number of linked equipment and the volume transmitted in the increasing network. Research has recently been carried out on the hybrid Li-Fi / Wi-Fi network. Two twins can be combined to create safer and more reliable wireless service via Li-Fi and Wi-Fi. Li-Fi supports high data rates and wireless Internet connection allows full coverage. Users can thus usually choose Li-Fi for high data rates and automatically switch to Wi-Fi when the light is obscured or when going outside of the Li-Fi Range. Since some of the network loads are supported by Li-Fi, Wi-Fi users can gain user experience through more connectivity tools. As an addition to Wi-Fi, Li-Fi can significantly enhance network quality. For the future, the hybrid Li-Fi / Wi-Fi network is going to extend across the globe, making us life free of secret Internet corners.

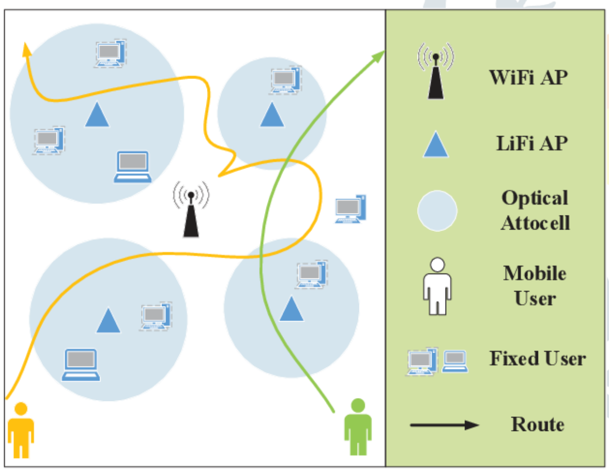
The LED lamps would operate in a linear region where the output optical power is proportional to the modulated input voltage [6]. As the frequency of Wi-Fi get increases simultaneously the Radius of Li-Fi area gets decreases, it depends on the data area that is provided to the Li-Fi modulation [7].

In comparison, the performance of the optical attocell network is equivalent to that obtained by other Radio frequency cellular networks. It is also proposed as a small indoor cellular network based on VLC. Basically attocell is a one type of small femtocell for Radio cellular system that can use VLC Range for transmission.Single attocell can't provide access to user who is outside the Range of AP. Thus, by taking more than one attocell, there is room coverage with attocell that is to be considered if the user moves from one AP to another, then the next AP will provide connectivity to user, thus there is no connection loss occurs. This phenomenon will help to develop a Li-Fi environment and continue the process.

II. Study on Different Reviews

A dynamic LB scheme is proposed where the utility function considers system output and fairness. In order to better understand the transfer effect on LB, the service areas of the various APs are studied and the throughput of each AP is analyzed using the proposed LB scheme[2]. Hybrid network combining light fidelity (Li-Fi) and radio frequency (RF) wireless fidelity (Wi-Fi) networks is considered. An additional type of very small Li-Fi attocells using visible light spectrum provides a significant increase in wireless data throughput in the indoor environment while providing room lighting at the same time[2][3].

Figure 2: System model [4]



As shown in figure 1, users are randomly moving either in Li-Fi or Wi-Fienvironment. Each Li-Fi room is associated with Li-FiAP and whole environment is covered with Wi-Fi AP. When users are moving from one Li-Fi to other Li-Fi AP then automatic control will be transferred to other AP[3].

When dealing with scenario [2], the LB scheme is intended to be a single plane Li-Fi attocell encapsulated in Wi-Fi AP, so if users are increased, then the usual overload situation arises and users are operating under Wi-Fi AP, this will impact the average user data rate throughput.

The Li-Fi / Wi-Fi hybrid system model is considered, as shown in Figure 1[3]. This hybrid network encompasses the indoor area of Nc Li-Fi APs and a single Wi-Fi AP. In this case, users are evenly distributed and move randomly. All APs are linked to the CU via error-free interconnect connections. Every Li-Fi AP is a large light emitting diode (LED) lamp that contains several low-power LEDs, and each consumer has a photo detector (PD). It is presumed that all PDs are perpendicular to the surface.It implies that the exposure angle is equal to the incidence angle. The field of view (FoV) of the LEDs and PDs can be designed in such a way that the transmission can be contained within a certain area. Often, the walls of the space block the light entirely, which ensures there is no co-channel interference between the rooms.

The main objective of this paper is to define more than one Li-Fi attocell to be organized under Wi-FiAP which will illustrate that more users will operate within the Li-Fi AP, if they cross one Li-Fi AP region and then automatically position it in another Li-Fi AP. The hybrid approach of Li-Fi and Wi-Fi is also being discussed to address the issue of throughput. The handover between Li-Fi and Wi-Fi is a matter that needs to be addressed by attocell placement.

Fair and effective load balancing (LB) can be a problem in the hybrid Li-Fi / Wi-Fi network due to the small size of Li-Fi attocells. Some recent research focuses on the resource allocation (RA) problem in static systems where users are expected to be fixed[4]. In the indoor case, the coverage of the Wi-Fi AP is beyond a single room where each Li-Fi cell in the Li-Fi network is only a few square meters due to the rectilinear distribution of light[4].However, there are many light sources in the room for illumination purposes, and Li-Fi has made significant gains through the re-use of transmission resources. As a result, users can encounter several changes between Li-Fi attocells, which are small coverage ranges similar to femtocell in RF networks, while assuming user movement. The transfer between Li-Fi attocells is referred to as a horizontal transition and the transfer between Li-Fi and Wi-Fi APs is referred to as a vertical transition[3].

During the switch, the signalling data is shared between the user and the central unit (CU). This process takes an average time from about 30 ms to 3000 ms depending on the algorithms used[5] and there is a possibility of transmission losses occurring during this cycle. The transmission overhead must therefore be included in the design of the LB schemes for such hybrid networks. For traditional wireless RF networks, the switch happens when consumers receivea lower signal-to-noise ratio (SNR) from one base station to the next base station (BS).

As in [6], where users are assumed to be fixed, but in practical scenarios some users will be moving. However, in an indoor hybrid network, the stability issues have to be taken into account as a handover may prompt further handovers. For example, if a user is transferred from the Li-Fi layer to the Wi-Fi layer, it will increase the load in the respective Wi-Fi cell. Other users served by this Wi-Fi AP may have to be transferred to neighbouring Wi-Fi APs, or have reduced data rates. Also, due to the decrease in the load of the Li-Fi attocell, resources are freed up to enhance data rates to existing users. Thus, the aim is to develop LB schemes that ensure high user throughput and stable and fair handover efficiency.

Thus, each Li-Fi AP in this model covers a confined area, regarded as an attocell. In each attocell, the Li-Fi APs usethe same modulation bandwidth. Users that reside in the overlapping area of Li-Fi attocells and are served by the Li-Fi APs would experience Co-Channel Interference (CCI), which is treated as additional noise in this study. The Wi-Fi AP is assumed to cover the entire indoor area. Each user is either connected to a Li-Fi AP or the Wi-Fi AP for downlink wireless communications.

Main focus in this study is, the achievable data rates of users served by Li-Fi APs are higher than or equal to that ofusers allocated to the Wi-Fi AP. The Li-Fi throughput can be improved by increasing the Wi-Fi throughput. The service coverage of Li-Fi APs is connected regions, which are generally smaller than the entire Li-Fi attocells. The handover overhead must be considered in the design of LB schemes for such hybrid networks. In conventional mobile RF networks, handover occurs when users receive a lower signal-to-noise ratio (SNR) from the serving base station (BS) than that from other BSs [2].

Hybrid light fidelity (Li-Fi) and wireless fidelity (Wi-Fi) networks are an emerging technology for future indoor wireless communications [8]. This hybrid network combines the high-speed data transmission offered by visible light communicationand the ubiquitous coverage of radio-frequency techniques [8].While a hybrid network can improve the system throughputand users' experience, it also challenges the process of accesspoint selection (APS) due to the mixture of heterogeneous accesspoints [9].

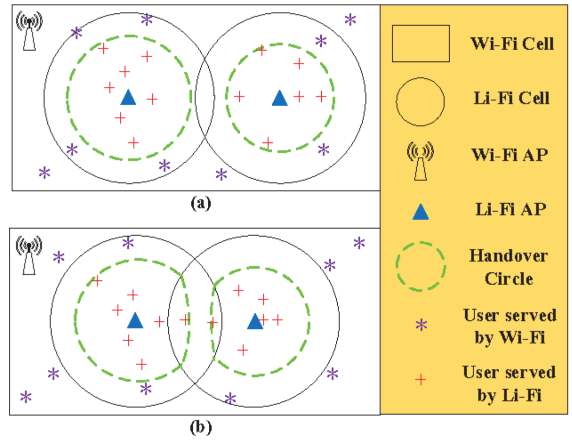
In this hybrid network, due to the fluctuating Channel State Information (CSI) of mobile users, the network load balancing should be undertaken in regular intervals. It is assumed that the CSI in both Li-Fi and RF systems remains constant for a short period which is defined as a state, and changes to a new value in the next state. The interval time between two neighbouring states is denoted by Tp. In each state, the load balancing configuration is assumed to be fixed and users receive constant data rates [3]. The natural number n denotes the sequence number of the states.

In the model, $C = \{c|\ c \in [0,Nc],\ c \in Z\}$ is denoted set of Li-Fi APs and the Wi-Fi AP, where $c = 0$ represents the Wi-Fi AP and $1 \le c \le Nc$ represents the Li-Fi APs[3]. The set of users is denoted by U. A full buffer traffic model is considered so that the maximum achievable data rate can be evaluated for each user at all times [4].

On the basis of moving user from one Li-Fi access point to another access point, there is a handover efficiency of user data rate is occurring that will be shown in Figure 2 [4].

In Li-Fi systems, the baseband communication with Intensity Modulation (IM) and Direct Detection (DD) is used in [6]. The Li-Fi signals are transmitted in the form of optical power, which should be positive and real. The LED lamps would operate in a linear region where the output optical power is proportional to the modulated input voltage. This region henceforth is termed as the linear working region of the LED. The signals outside this region are clipped before transmission. As the frequency of Wi-Fi get increases simultaneously the radius of Li-Fi area gets decreases, it depends on the data area that is provided to the Li-Fimodulation. Figure 1, shows the basic criteria of the handover of users in a hybrid network. In the working scenario, the hybrid network constituted by a Wi-Fi AP and to Li-Fi APs is considered. Consider that the radius of each Li-Fi attocell is 3m, and wall of the optical attocells reuse

Figure 3: Handover circle illustration



the same modulation bandwidth [1]. In Figure 2(a), only hybrid network is shown, where the handover circles are not merged and in Figure 2 (b) the handover circles are merged that is handover occur. When a handover circle does not overlap with other attocells, users allocated to the corresponding as shown in Figure 2(b).

The main objective of this study is, In order to know the hybrid model's function, user data rates are calculated. A selection of IEEE 802.11n and 802.11 ac standards will be used to manage the hybrid network on the Li-Fi AP with Wi-Fi AP. If the number of users in particular Li-Fi AP increases, the power is automatically moved to the Wi-Fi AP, without altering data rates. When the user transfers to wireless Internet AP, the data rate is consistent.

Conclusion

Handover is a process in networking in which a connected cellular data session is transferred from one base station to another without disconnecting the session. In hybrid network efficiency is beneficial as it is the ability to produce output with a minimum amount of effort.Hybrid network handover allows users to effectively manage the data rate, for example when the user switches from one Li-Fi AP to another Li-Fi AP then immediately transfers access to another AP. If the load on Li-Fi AP is rising, Wi-Fi AP is enabled and switch to Wi-Fi AP, can be managed to improve the efficiency.

Hybrid network performance offers benefit both for the user and for the load balance of the Li-Fi AP simultaneously. Throughput of Li-Fi and Wi-Fi will help to take an estimated value that allows carrying the actual data rate fluctuations in handover area. Estimated hybrid network performance allows the proposed system to work accurately. The Li-Fi and Wi-Fi hybrid approach to dealing with the problem of reliability. The handover between Li-Fi and Wi-Fi must be deal with Attocell.

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